

1     CLAIMS:

2     1. A method comprising employing a vocabulary of color names in assigning a color  
3     name to a pixel in a digital representation, including the steps of:

4         providing said vocabulary of color names with a plurality of color prototypes,  
5     each said color prototype having a prototype color name and a corresponding prototype  
6     color value;

7         comparing a pixel color value of said pixel to said prototype color value of each  
8     color prototype in the vocabulary, and obtaining a color match value for said each color  
9     prototype in the vocabulary;

10        determining a closest color match value resulting from said step of comparing;  
11     and

12        assigning to said pixel a particular prototype color name corresponding to said  
13     closest match value.

14     2. A method as recited in claim 1, further comprising forming said vocabulary of color  
15     names, includes the steps of:

16        obtaining at least one general set of essential color names, each essential color  
17     name having a corresponding color value;

18        whereby each color name includes a hue descriptor, brightness modifier, and  
19     saturation modifier; and

20        selecting a subset of said at least one general set in meeting an application desire  
21     for said vocabulary of color names.

22     3. A method as recited in claim 2, wherein the step of obtaining includes starting with a  
23     large number of arbitrary color names having corresponding color values and modify  
24     them through subjective (perceptual) experiments to obtain a general set that models  
25     human behavior in color naming

26     4. A method as recited in claim 1, wherein the step of comparing includes the steps of:

1           computing a color distance in a selected color space between the color value of  
2   said pixel and said prototype color value;  
3           finding the closest perceptual match to the prototype color value for said color  
4   distance;  
5           computing an estimate value of perceptual dissimilarity between said closest  
6   perceptual match and color value of said pixel; and  
7           using said estimate value to modify said color distance, thereby obtaining said  
8   color match value.

9   5. A method as recited in claim 1, wherein the step of determining includes finding the  
10   prototype color value having the minimum color naming distance to the color value of  
11   said pixel.

12   6. A method as recited in claim 1, further comprising:  
13           acquiring a digital representation of a scene;  
14           employing said vocabulary in providing a description of a color composition in  
15   said scene.

16   7. An article of manufacture comprising a computer usable medium having computer  
17   readable program code means embodied therein for causing assignment of a color name,  
18   the computer readable program code means in said article of manufacture comprising  
19   computer readable program code means for causing a computer to effect the steps of  
20   claim 1.

21   8. A program storage device readable by machine, tangibly embodying a program of  
22   instructions executable by the machine to perform method steps for assigning a color  
23   name, said method steps comprising the steps of claim 1.

24   9. An apparatus comprising means for employing a vocabulary of color names in  
25   assigning a color name to a pixel in a digital representation, including:

1 means for providing said vocabulary of color names with a plurality of color  
2 prototypes, each said color prototype having a prototype color name and a corresponding  
3 prototype color value;  
4 means for comparing a pixel color value of said pixel to said prototype color value  
5 of each color prototype in the vocabulary, and obtaining a color match value for said each  
6 color prototype in the vocabulary;  
7 means for determining a closest color match value resulting from said step of  
8 comparing; and  
9 means for assigning to said pixel a particular prototype color name corresponding  
10 to said closest match value.

11 10. An apparatus as recited in claim 9, further comprising means for forming said  
12 vocabulary of color names, including:

13 means for obtaining at least one general set of essential color names, each  
14 essential color name having a corresponding color value;

15 means for whereby each color name includes a hue descriptor, brightness  
16 modifier, and saturation modifier; and

17 means for selecting a subset of said at least one general set in meeting an  
18 application desire for said vocabulary of color names.

19 11. An apparatus comprising:

20 means for obtaining a vocabulary of color names;

21 means for acquiring a digital representation of a scene; and

22 means for employing said vocabulary in providing a description of a color  
23 composition in said scene.

24 12.. Apparatus as recited in claim 11, wherein the means for providing includes means for  
25 employing color names in describing the scene and in describing objects in said scene.

1     13. A computer program product comprising a computer usable medium having  
2     computer readable program code means embodied therein for causing assignment of a  
3     color name to a pixel in a digital representation, the computer readable program code  
4     means in said computer program product comprising computer readable program code  
5     means for causing a computer to effect the functions of claim 9.

6     14. A computer program product comprising a computer usable medium having  
7     computer readable program code means embodied therein for causing provision of a  
8     description of a color composition in a scene, the computer readable program code means  
9     in said computer program product comprising computer readable program code means for  
10    causing a computer to effect the functions of claim 11.

11    15. A method comprising:  
12         obtaining a vocabulary of color names;  
13         acquiring a digital representation of a scene; and  
14         employing said vocabulary in providing a description of a color composition in  
15    said scene.

16    16. A method as recited in claim 15, wherein the step of providing includes employing  
17    color names in describing the scene and in describing objects in said scene.

18    17. A method as recited in claim 15, wherein the step of employing includes:  
19         computing a simplified representation of said scene to model a human perception  
20    of said scene;  
21         segmenting a digital image representing said scene into a set of meaningful  
22    regions;  
23         computing a perceived color value for each said meaningful region;  
24         assigning a region color name from said vocabulary to each said meaningful  
25    region;

1           using said region color names to describe the color composition of said scene at  
2           different accuracy levels;

3           18. A method as recited in claim 15, further comprising computing a simplified  
4           representation of said scene corresponding to a human observation of said scene.

5           19. A method as recited in claim 18, wherein the step of computing a simplified  
6           representation of said scene includes:

7                 applying a chromatic transformation to accommodate for a particular illumination  
8                 condition of said scene;

9                 labeling said each pixel in said image with a label of a descriptive type to  
10                correspond with the descriptive type of an element of said scene to which said each pixel  
11                belongs;

12               performing adaptive smoothing of said image with an amount of smoothing  
13               around said each pixel in correspondence with the descriptive type of said each pixel;

14               for said each pixel , determining whether said each pixel is a perceptually  
15               significant pixel or a perceptually insignificant pixels; and

16               reapplying chromatic transformation to preserve a color appearance as perceived  
17               in said human observation.

18           20. A method as recited in claim 19, wherein the step of labeling includes:

19               determining if said each pixel in said image represents an edge;

20               estimating distribution of edge density in a neighborhood of said each pixel in  
21               said image; and

22               using said distribution to determine a descriptive type of said each pixel and  
23               labeling said each pixel accordingly.

24           20. A method as recited in claim 19, wherein the descriptive type includes a type taken  
25           from a group of types including: uniform, noise, contour, region boundary, texture  
26           boundary, transition region, coarse texture, and fine texture.

- 1 21. A method as recited in claim 19, wherein said step of determining includes deeming  
2 said each pixel to be perceptually significant if said each pixel is at least one of: uniform,  
3 in a dominant object, in a dominant background, coarse texture and fine texture.
- 4 22. A method as recited in claim 19, wherein said step of determining includes deeming  
5 said each pixel to be perceptually insignificant if said each pixel is at least one of: noise,  
6 contour, region boundary, texture boundary, and transition region.
- 7 23. A method as recited in claim 19, wherein the step of labeling produces a label for said  
8 each pixel, and the step of smoothing includes:  
9 obtaining the label for said each pixel in said image; and  
10 using said label for said each pixel in determining a smoothing filter to be used for  
11 said each pixel in said image.
- 12 24. A method as recited in claim 19, wherein the step of smoothing is performed only on  
13 perceptually significant pixels.
- 14 25. A method as recited in claim 23, further comprising changing said smoothing filter  
15 depending on a particular descriptive type of a particular pixel in a center of the  
16 smoothing filter.
- 17 26. A method as recited in claim 23, wherein said support of a smoothing filter is largest  
18 for pixels labeled uniform and smallest for pixels labeled coarse texture.
- 19 27. A method as recited in claim 17, wherein the step of segmentation includes at least  
20 one of the following: color segmentation, texture segmentation, region growing, region  
21 merging, region splitting, multiresolution segmentation.

- 1 28. A method as recited in claim 17, wherein the step of computing a perceived color  
2 value for a meaningful color region includes:  
3 changing a pixel value of each perceptually insignificant pixel in said region into a  
4 new value equal to the pixel value of a closest perceptually significant pixel from said  
5 region; and  
6 averaging color values of all pixels in said region.  
7
- 8 29. A method as recited in claim 17, wherein the step of assigning includes:  
9 providing said vocabulary of color names with a plurality of color prototypes,  
10 each said color prototype having a prototype color name and a corresponding prototype  
11 color value;  
12 comparing said perceived color value of each said meaningful region to said  
13 prototype color value of each color prototype in the vocabulary, and obtaining a color  
14 match value for said each color prototype in the vocabulary;  
15 determining a closest color match value resulting from said step of comparing;  
16 and  
17 assigning to said meaningful region a particular prototype color name  
18 corresponding to said closest match value.
- 19 30. A method as recited in claim 29, further comprising forming said vocabulary of color  
20 names, including the steps of:  
21 obtaining at least one general set of essential color names, each essential color  
22 name having a corresponding color value;  
23 wherein each color name includes a hue descriptor, brightness modifier, and  
24 saturation modifier; and  
25 selecting a subset of said at least one general set in meeting an application desire  
26 for said vocabulary of color names.
- 27 31. A method as recited in claim 17, wherein the step of using includes:  
28 providing a set of rules defining accuracy levels in color naming;

1           selecting an accuracy level meeting an application desire; and  
2           computing a histogram of color names for said scene, for said selected accuracy  
3   level.

4   32. A method as recited in claim 31, further comprising forming said rules, includes the  
5   steps of:

6           obtaining a set of accuracy levels describing human behavior in color naming; and  
7           deriving rules whereby color names and each accuracy level include at least one  
8   of: a hue descriptor, a combination of brightness modifiers, and a saturation modifier.

9   33. A method as recited in claim 31, wherein the set of accuracy levels is determined  
10   employing subjective experiments modeling human behavior in color naming

11   34. A method as recited in claim 31, wherein the step of computing a histogram of color  
12   names for said scene includes:

13           determining color names present in said scene;  
14           computing a total area for each said color name;  
15           discarding color names not meeting an area criterion; and  
16           combining color names according to said rule for said selected accuracy level.

17  
18   35. A method as recited in claim 34, further comprising :  
19           providing color names for objects in said scene; and  
20           pointing out examples of named color in said scene.

21   36. A method comprising computing a simplified representation of a scene consistent  
22   with human observation of said scene, including the steps of:

23           applying chromatic transformation to accommodate for different illumination  
24   conditions;  
25           labeling pixels in said scene into different pixel types;



1 performing adaptive smoothing of said image where the amount of smoothing  
2 around each pixel depends on the type of said pixel;  
3 determining perceptually significant pixels and perceptually insignificant pixels;  
4 and  
5 reapplying chromatic transformation to preserve the color appearance to the  
6 human observer;

7 37. An article of manufacture comprising a computer usable medium having computer  
8 readable program code means embodied therein for causing provision of a description of  
9 a color composition in a scene, the computer readable program code means in said article  
10 of manufacture comprising computer readable program code means for causing a  
11 computer to effect the steps of claim 15.

12 38. A program storage device readable by machine, tangibly embodying a program of  
13 instructions executable by the machine to perform method steps for providing a  
14 description of a color composition in a scene, said method steps comprising the steps of  
15 claim 15.

16 39. An article of manufacture comprising a computer usable medium having computer  
17 readable program code means embodied therein for causing provision of a description of  
18 a color composition in a scene, the computer readable program code means in said article  
19 of manufacture comprising computer readable program code means for causing a  
20 computer to effect the steps of claim 36.

21 40. A program storage device readable by machine, tangibly embodying a program of  
22 instructions executable by the machine to perform method steps for providing a  
23 description of a color composition in a scene, said method steps comprising the steps of  
24 claim 36.